CHEMICAL HAZARD SUMMARY
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ISOPROPYL ALCOHOL

Other Names	2-Propanol, isopropanol, sec-propyl alcohol, dimethylcarbinol, CAS 67-63-0
Description	Colourless liquid with odour of rubbing alcohol.

HAZARD SUMMARY

Exposure	Vapour: Inhalation, eye contact. Liquid: Eye contact, skin contact and ingestion.
Effects of Short-Term Exposure	Vapours may cause irritation of eyes, nose and throat. Accidental splashes of liquid may cause eye damage. An allergic skin reaction may occasionally occur. Ingestion may cause stomach pain, cramps, vomiting, diarrhea, nausea, headache, dizziness, mental depression, and confusion. Coma and death may follow massive exposures.
Effects of Long-Term Exposure	No long-term health effects have been reported in humans. Isopropyl alcohol is not carcinogenic. The manufacture of isopropyl alcohol by the obsolete strong acid process is carcinogenic in humans.
Fire and Explosion Hazards	Highly flammable; dangerous fire risk. At room temperatures, vapours can readily form flammable or explosive mixtures with air. Vapours may spread from the spill site and ignite. Containers may explode in the heat of a fire.
Fire Extinguishers	Dry chemical, carbon dioxide, alcohol foam, water spray or fog. Do not use a direct water stream since this will scatter and spread the fire. Use water spray to cool containers.
Chemical Reactivity	Normally stable. Contact with oxidizing agents increases risk of fire and explosion.
Personal Protection	Wear protective clothing as needed to prevent exposure of skin to liquid or concentrated vapours. For eye or face protection, wear splash-proof chemical safety goggles or a face shield (8-inch minimum). Respirators are essential whenever vapour

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Personal Protection	concentrations exceed permissible limits. The type of respirator needed depends on the concentration of isopropyl alcohol in the workplace.
Storage	Store isopropyl alcohol in tightly closed, labelled, containers in a cool area with adequate ventilation. Store away from normal work areas and sources of heat, sparks and oxidizing agents.
Exposure Limits	As recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) 1986-87: Time Weighted Average Exposure (TWA): 400 ppm (parts per million) or 980 mg/m^3 (milligrams per cubic metre) Short Term Exposure Limit (STEL): 500 ppm or 1,225 mg/m^3

TWA is defined as the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek.

STEL is defined as a 15-minute time-weighted average exposure which should not be exceeded at any time during a workday. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL.

SCOPE OF THE DOCUMENT

This summary was prepared at the Canadian Centre for Occupational Health and Safety (CCOHS) and is intended primarily as a source of information for persons who work with or may be occupationally exposed to this material. The information selected for inclusion is believed to be reliable and generally relevant to occupational health. Other information may be available which bears on particular work situations. The scientific data in many areas are limited and may allow a variety of interpretations. Additional information, corrections, comments, and questions are welcome, and should be addressed to the Inquiries Service, CCOHS, 250 Main Street East, Hamilton, Ontario, L8N 1H6, (416) 572-2981 or toll-free, 1-800-263-8276.

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I. USES AND OCCURRENCE

The most important use of isopropyl alcohol is in the manufacture of acetone.

Isopropyl alcohol is a common industrial solvent for oils, gums, shellacs, waxes, resins, paints, varnishes, cellulose derivatives, lacquers and drug or cosmetic preparations.

Isopropyl alcohol is used in cleaning and dehydrating operations, in extraction processes, as a poison added to alcohol to make it unfit for drinking, as a preservative for biological specimens, for the production of other chemicals, and in de-icing and antifreeze products.

A 70% solution of isopropyl alcohol in water is widely known as rubbing alcohol, a popular massage solution. A 30-50% solution of this alcohol in water is used as an antiseptic and disinfectant for home, hospital and industrial use.

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Isopropyl alcohol is a common ingredient in hair sprays, hand lotions, liniments, liquid soaps, window cleaners, windshield washer fluid, insecticides, shoe polishes, air fresheners and many other commercial products.

II. TOXICOLOGY

Routes of Exposure
Inhalation and skin contact are the most common routes of exposure in the workplace. Less common routes are eye contact and ingestion.

Isopropyl alcohol is rapidly absorbed from the lungs and digestive tract and is then distributed throughout the body. It is poorly absorbed through intact skin.

General information on routes of exposure is available in the CCOHS publication "How Workplace Chemicals Enter the Body"[1].

Removal from the Body
Most of the absorbed isopropyl alcohol is rapidly broken down by the liver into acetone. The remainder is excreted unchanged in urine and in exhaled air.

The odour of acetone can be detected on the breath within 15 minutes following ingestion of isopropyl alcohol and in the urine within the first hour. It may still be detected in the urine after 48 hours. In most cases of poisoning, the odour of acetone is detected on the breath of the victim.

Effects of Short-Term Exposures in Humans
Isopropyl alcohol is related to ethyl alcohol ("common" alcohol). Many of the toxic effects of isopropyl alcohol are similar to those of ethyl alcohol.

Inhalation
Irritation of the nose and throat are the usual symptoms of exposure to isopropyl alcohol at concentrations of 400 ppm (980 mg/m^3)[2]. Some irritation may occur at concentrations below 400 ppm, as may drowsiness, headache and incoordination.

No cases of industrial poisoning from exposure to isopropyl alcohol vapours have been reported. However, in non-occupational exposures, poisoning to the extent of loss of consciousness has been reported in children inhaling vapours from towels soaked in isopropyl

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alcohol during "sponge baths" intended to reduce fever. There was recovery in all cases[3].

Effects on the Skin
Isopropyl alcohol is not a skin irritant[4], although several cases of allergic reactions to skin contact have been reported[5,6]. Repeated skin contact may cause drying and flaking of the skin.

Effects on the Eyes
Isopropyl alcohol vapours can irritate the eyes at concentrations of 400 ppm (980 mg/m^3)[2].

Accidental splashes may cause corneal burns and eye damage[7].

Ingestion
Many non-occupational poisonings have resulted from the ingestion of isopropyl alcohol[3,8]. Signs of intoxication are similar to those of ethyl alcohol. Ingestion of about 28 ml (1 ounce) of isopropyl alcohol with water causes a drop in blood pressure, dizziness and flushing of the face. The feeling of euphoria associated with alcohol intoxication is lacking. Two to three hours later, more severe symptoms including headache, mental depression, body ache, nausea and vomiting may develop. In some cases these symptoms persist for more than 24 hours. The body breaks down isopropyl alcohol into acetone and many symptoms are due to acetone formation[9].

In extreme cases of poisoning there may be deep coma and shock leading to death. Acute kidney failure has been reported in several cases[10]. Lethal dose is about 500 ml (1 pint) of 70% isopropyl alcohol[11]. Others have survived after ingesting similar amounts[10]. Ingestion of isopropyl alcohol interferes with Antabuse treatment of alcohol addiction.

Effects of Long-Term Exposures
Long-term exposure to isopropyl alcohol does not appear to cause any problems beyond those seen with short-term exposure. No long-term health effects have been reported in humans. Liver damage, as seen in alcoholics, might be expected following long-term exposure to isopropyl alcohol.

Carcinogenic Effects
There is no evidence that isopropyl alcohol is a carcinogen. Tests in laboratory animals have been negative[12,13].

Occupational nose and larynx cancers are seen in people exposed during certain isopropyl alcohol manufacturing processes[12,14-16].

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However, the increased cancer incidence appears to be associated with the "strong-acid" manufacturing method rather than with isopropyl alcohol itself[12]. Chemical intermediates or waste products of the process are considered to be the cancer-causing agents[12,17,18]. Conversion to weak-acid processes and modern engineering controls are believed to have eliminated the cancer hazard[19]. However, no reports were located on the cancer incidence in factories using the weak-acid or other processes.

Reproductive Hazards
No reports were located on the effects of isopropyl alcohol on pregnant women.

Studies in laboratory animals are widely used to indicate the potential of a chemical to cause reproductive effects in humans.

Isopropyl alcohol was given continuously in drinking water in doses of 1.5, 1.4 and 1.3 g/kg/body weight/day to parents and to two successive generations of rats[20]. No reproductive effects were seen in these animals except for a temporary reduction in growth early in the first generation.

Mutagenic Effect
No studies on the mutagenic effects of isopropyl alcohol appear to be available.

Toxicity Data in Animals
The relative poisoning potential of a compound can be assessed from the LD_{50} obtained in animal tests. The LD_{50} is the amount of a chemical (weight of chemical/weight of animal) which is needed to kill one-half (50%) of the test animals. Test animals are usually rats, mice, or other rodents. Routes of exposure are usually oral (by mouth), dermal (absorption through the skin), or inhalation (breathing of vapour). The values for this material are:

LD_{50} (rat, oral)	4.7-5.8 g/kg[21]
LD_{50} (rabbit, dermal)	13 g/kg[22]
LD_{50} (rat, inhalation)	16,000 ppm/8 hours[22]

These values indicate that the acute toxicity of isopropyl alcohol in animals is low. The odour and irritating effects should prevent exposure to acutely hazardous amounts of the vapours.

General information on the LD_{50} is available in the CCOHS publication "What is an LD_{50}?"[23].

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III. FIRE AND EXPLOSION HAZARDS

Isopropyl alcohol is a highly flammable liquid and poses a dangerous fire risk. At room temperatures, vapours can readily form flammable or explosive mixtures with air. The vapour is much heavier than air and may travel considerable distances to source of ignition and flashback. Containers may explode in the heat of a fire.

Flash Point
The flash point of isopropyl alcohol is about 12°C (52°F). When the liquid is heated above this temperature enough vapour is produced to form a flammable or explosive mixture of vapour and air.

Explosive Limits in Air
The lowest concentration of vapour in air which can burn or explode is called the lower flammable limit (LFL) or lower explosive limit (LEL) and is 2.5% (25,000 ppm) for isopropyl alcohol. Similarly, the highest concentration of vapour in air which can burn or explode is called the upper flammable limit (UFL) or upper explosive limit (UEL) and is 12% (120,000 ppm) for isopropyl alcohol. Between the LEL and the UEL, possible hazards include explosion in confined spaces or a fire travelling along the line of vapour from a spark or flame to a container or spill (flashback). Adequate ventilation can prevent the accumulation of explosive concentrations of vapour in work or storage areas.

Fire Extinguishing Agents
For fires involving isopropyl alcohol use dry chemical, carbon dioxide, alcohol foam, water spray or fog extinguishing agents. Do not use direct water streams since the streams will scatter and spread the fire. Use water spray to cool containers.

Chemical Reactivity
Isopropyl alcohol is normally stable. Contact with oxidizing agents increases the risk of fire and explosion. It reacts explosively with phosgene, fuming nitric acid, fuming sulfuric acid (oleum), potassium tert-butoxide, aluminum powder, palladium particles and iron salts.

IV. EXPOSURE CONTROL

General or dilution ventilation may be adequate for operations where isopropyl alcohol is used in small amounts at room temperatures. Use explosion-proof local exhaust ventilation systems where mists or high vapour concentrations may be present. Exhaust contaminated air

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directly to outside. Supply sufficient replacement air to make up for air removed by exhaust ventilation systems. Check the system regularly to ensure that the ventilation is functioning properly.

Use personal and respiratory protective equipment in situations where effective ventilation and engineering controls are not possible.

Protective Clothing
Wear protective clothing (gloves, aprons, coveralls, boots) as needed to prevent exposure of skin to liquid or concentrated vapours. Isopropyl alcohol is a strong solvent and many materials do not provide adequate protection. Clothing made with neoprene, natural rubber or polyethylene can resist penetration and deterioration by isopropyl alcohol. Clothing coated with polyvinyl chloride may also provide good protection.

Promptly remove any regular clothing which becomes contaminated with isopropyl alcohol. Discard or launder separately before reuse.

Wear splash-proof chemical safety goggles or a face shield (eight-inch minimum) whenever there is a risk of splashing liquid into the eyes.

Locate eye-wash fountains and safety showers in areas where isopropyl alcohol splashes may occur.

Respiratory Protection
Factors to be considered when implementing a respiratory protection program include:

- Selection of appropriate respirators
- Respirator fit
- Respirator maintenance
- Cartridge life
- Worker training
- Inspection
- Cleaning
- Program evaluation

These factors are described in more detail in the CSA Standard Z94.4-M1982, "Selection, Care, and Use of Respirators", available from the Canadian Standards Association.

The degree of respiratory protection required depends on the concentration of the vapour and the duration of the exposure. National Institute for Occupational Safety and Health (NIOSH)[24] recommends

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the following respiratory protection for isopropyl alcohol vapour concentrations*:

Vapour concentration of 1,000 ppm (2,450 mg/m^3) or less:
**Any powered air purifying respirator with organic vapour cartridge, or
Any chemical cartridge respirator with a full facepiece and organic vapour cartridge

Vapour concentration of 10,000 ppm (24,500 mg/m^3) or less:
**Any supplied-air respirator operated in a continuous flow mode.

Vapour concentration of 20,000 ppm (49,000 mg/m^3) or less:
Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour cartridge, or
Any self-contained breathing apparatus with a full facepiece, or
Any supplied-air respirator with a full facepiece.

Emergency or planned entry in unknown concentration or Immediately Dangerous to Life or Health (IDLH) conditions***:
Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode, or
Any supplied-air respirator with a full facepiece and operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.

*Note: The above recommendations apply only to equipment approved by NIOSH or Mine Safety and Health Administration (MSHA).

**Note: Substance causes eye irritation or damage; eye protection needed.

***Note: For the purpose of respirator selection, the IDLH level represents the maximum concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects.

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Escape:
Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour cartridge, or
Any appropriate escape-type self-contained breathing apparatus.

Respirators and gas masks fitted with organic vapour cartridges can provide protection against vapours of isopropyl alcohol for a limited period of time. The useful life of a respirator depends on the amount of absorbent material in the cartridge, the concentration of vapours, the temperature, and the rate of breathing.

V. SMALL-SCALE STORAGE AND HANDLING

Store isopropyl alcohol in tightly-closed, labelled, electrically-grounded containers in a cool area separate from normal work areas. Provide adequate ventilation to the storage area. Ensure there are no sources of heat, flames or sparks. Use approved safety solvent containers. Cover containers when not in use and store in a fire-resistant grounded cabinet. Use spark-resistant electric switches and motors (fans, refrigerators). Prohibit smoking in or near storage area.

Use isopropyl alcohol in minimal quantities in designated areas with adequate ventilation and away from sources of heat or sparks and oxidizing agents. Ground containers during mixing or transfer. Use fire-resistant containers whenever possible. Wear appropriate protective equipment to prevent skin and eye contact.

Cleanup and Disposal
Provide adequate ventilation, protective clothing and respirators. Remove all sources of heat, sparks or flames before attempting to clean up a spill. Stop the flow if it can be done safely and contain spilled material. For small quantities, absorb spills on paper towels and evaporate in a safe place (such as a fume hood). Larger quantities may be collected in sand, dry clay, sawdust, or other absorbent materials and placed in sealable containers for later disposal.

Consult the federal, provincial and local governments for advice on disposal. Do not discharge waste isopropyl alcohol directly into surface waters or sewers.

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VI. FIRST AID

The following general procedures are suggested for first aid involving poisoning by isopropyl alcohol:

Inhalation
Remove the source of contamination and move the victim to fresh air. If breathing has stopped, properly trained personnel should begin artificial respiration or cardiopulmonary resuscitation (CPR) immediately. Obtain medical attention immediately.

Skin
As quickly as possible, flush the contaminated area with lukewarm, gently running water for at least 20 minutes. Remove contaminated clothing promptly and discard or launder separately. Dry thoroughly before re-use.

Eyes
As quickly as possible, flush contaminated eye(s) with lukewarm, gently flowing water for 20 minutes, holding the eyelid(s) open. Obtain medical attention immediately.

Ingestion
When isopropyl alcohol has been swallowed, obtain medical attention immediately. Never give anything by mouth if the victim is rapidly losing consciousness or is unconscious or convulsing. DO NOT INDUCE VOMITING. Victim may drink 8 to 10 ounces (240 to 300 ml) of water to dilute material in the stomach. If vomiting occurs naturally, have the victim lean forward to reduce the risk of drawing liquid isopropyl alcohol into the lungs.

Note: Consult a physician and/or the nearest Poison Control Centre for all cases of ingestion or eye contact and all but trivial cases of inhalation or skin contact.

VII. EXPOSURE LIMITS

In many Canadian jurisdictions, exposure limits are similar to the Threshold Limit Values (TLVs) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). For isopropyl alcohol the 1986-87 recommended TLVs are:

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1. Threshold Limit Value-Time Weighted Average (TLV-TWA) =
   400 parts per million (ppm) or 980 milligrams per cubic metre (mg/m^3):

This is "—the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect."

2. Threshold Limit Value-Short Term Exposure Limit (TLV-STEL) =
   500 parts per million (ppm) or 1,225 milligrams per cubic metre (mg/m^3):

"A STEL is defined as a 15-minute time-weighted average exposure which should not be exceeded at any time during a workday even if the eight-hour time-weighted average is within the TLV. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL."

"The STEL is not a separate independent exposure limit, rather it supplements the time-weighted average (TWA) limit where there are recognized acute effects from a substance whose toxic effects are primarily of a chronic nature. STELs are recommended only where toxic effects have been reported from high short-term exposures in either humans or animals."

Certain Canadian jurisdictions have adopted the entire set of ACGIH TLVs for chemical substances by reference in their regulations. Others use the TLVs as guidelines for control of airborne contaminants. Still others specify exposure limits for chemical substances, including isopropyl alcohol, in their regulations. Since the manner in which exposure limits are established, interpreted and implemented can vary among the jurisdictions, detailed information should be sought from the appropriate government agency in each jurisdiction.

According to the preface in the ACGIH booklet:

"Threshold limit values refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed

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day after day without adverse effect. Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at concentrations at or below the threshold limit; a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness."

"Threshold limits are based on the best available information from industrial experience, from experimental human and animal studies and, when possible, from a combination of the three."

"The TLV-TWA should be used as guides in the control of health hazards and should not be used as fine lines between safe and dangerous concentrations." (Reproduced by permission of the ACGIH).

Warning Properties of Isopropyl Alcohol at the Exposure Limit

For certain substances, odour or irritant properties may be useful as a short-term indicator of possibly hazardous conditions. The odour threshold of isopropyl alcohol ranges from 40 ppm (98 mg/m^3)[25] to 200 ppm (490 mg/m^3)[26], and it should be detectable by smell at concentrations below current exposure limits. Isopropyl alcohol is considered to be a material with good warning properties. However, reliance on the odour of isopropyl alcohol to provide warning of possible overexposure is not recommended because of the possibility of a temporary loss of the sense of smell (olfactory fatigue), individual variation and the possible presence of other odourous materials in the workplace.

Exposure Limits in Other Nations

The approaches or mechanisms for establishing and applying occupational exposure limits can vary widely from country to country. Information on exposure limits in a number of foreign jurisdictions is available from CCOHS.

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VIII. CHEMICAL AND PHYSICAL PROPERTIES

CAS registry number	67-63-0
Chemical formula	C_3H_8O
Chemical structure	$CH_3CHOHCH_3$

Physical Properties

Boiling point	82°C (180°F)
Melting point	-86°C (-122°F)
Density	0.7874 (water = 1)
Solubility	Miscible (soluble in all proportions) in water
Vapour pressure	44 mm Hg (at 25°C)
Vapour density	2.07 (air = 1)
Odour threshold	40 to 200 ppm
Flash point	12°C (52°F) closed cup
Explosive limits	Upper: 12% Lower: 2.5%
Autoignition temperature	399°C (750°F)

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Note: Additional references on this subject are available from CCOHS upon request.

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